

# Toxic Chemicals in Agriculture **RESIDUES IN FOOD**

*REPORT OF THE  
WORKING PARTY*

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# TOXIC CHEMICALS IN AGRICULTURE

## RESIDUES IN FOOD

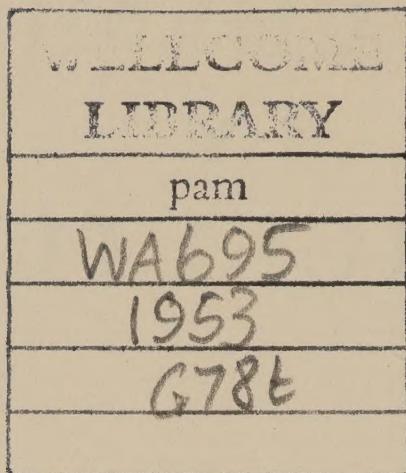
*Report to the  
Ministers of Agriculture and Fisheries,  
Health, and Food, and to the Secretary  
of State for Scotland*

*of*

*the Working Party on  
Precautionary Measures against Toxic Chemicals  
used in Agriculture*

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**Report to the Ministers of Agriculture and Fisheries, Health,  
and Food, and to the Secretary of State for Scotland of the  
Working Party on Precautionary Measures against Toxic  
Chemicals used in Agriculture.**

## **I. INTRODUCTION**

1. The widespread interest now shown in certain possibly dangerous effects of the chemical treatments used to protect growing crops, livestock and stored food is largely due to the relatively recent introduction of pest killers with which we are less familiar than we are with the better-established poisons. In some cases these treatments, repeated annually, provide the only known means by which diseases, pests and weeds can be controlled. In others they are necessary only when the weather or some other condition favours the spread of a particular scourge. Whatever the circumstances which call for their use, they have proved their worth in reducing waste, both in the production and the storage of food, and it is to be expected that these treatments will remain normal practice in many branches of agriculture and horticulture, and that they will go on being used on an ever-increasing scale.

2. Unfortunately, almost all the insecticides and weed-killers are toxic to forms of life other than the pests they were designed to control and, if improperly used, they may constitute a serious hazard, not only to domestic animals and many wild creatures, but also to man—although here the risks can sometimes be greatly reduced by the correct timing of the treatments. The Working Party hope that further research will disclose alternative pest-controlling substances which will have a greater selective toxicity to insects, weeds and fungi. Until, however, such compounds are discovered, the only way in which the present danger can be mitigated is by efficient control of the operations.

3. Our first report\* (January, 1951) dealt with the protection of the men who spread the new pesticides and weed-killers, and particularly with the problem of offsetting the hazards they run when applying the more noxious of these crop-protecting chemicals. This problem was fairly straightforward since the dangers were obvious, and since all people engaged in the work, from the farm worker to the spraying contractor, were equally anxious to devise reasonable measures of protection. Legislation has now been enacted to embody our recommendations. Our second task, that of considering the possible hazards run by the consumer who eats food which, at an earlier stage in its history, was treated with, or exposed to, some toxic chemical, has proved far more difficult, and is the subject of this report.

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\**Toxic Chemicals in Agriculture*, H.M. Stationery Office, 1951.

4. In spite of searching inquiries to as many official and unofficial bodies as one might suppose could provide relevant information, and whom we list later in this report, we have been unable to discover any specific instances of illness which have resulted from eating such food. The position does not therefore appear to have been established as one of immediate danger.

5. On the other hand, it is not one which allows of complacency. While the present lack of any system of notification makes it impossible to find out what proportion of the food we eat is being treated with these less familiar chemicals, the increasing rate of introduction of new and potentially dangerous compounds indicates that measures need to be taken to ensure that the situation does not get out of hand, and that new materials are not used on a commercial scale until at least a specified minimum of information is available concerning their toxicity, and concerning the residues they leave on foods.

6. Certain of our previous recommendations were inspired by the need to protect the public interest, as opposed to the more specific one of the people who actually apply the chemicals. Thus we recommended that warning notices should be placed on gates giving access to fields that are being, or have recently been, sprayed ; that surplus spray material should be safely disposed of to avoid any possible contamination of ponds or streams ; and that farm animals should be kept away from spraying operations and from fields that have recently been sprayed. We also recommended that it would be in the interest of the retailers of chemical formulations, as well as of the public, that the sale of preparations containing dinitro and organo-phosphorus substances should either be brought under statutory control, or restricted. This recommendation has now been implemented. In the present report we take the problem of the risk to the consumer as far as we believe we legitimately can on the basis of real information. In the next part of our work we propose to consider the dangers to which animal and plant life are exposed as a consequence of the use of various pesticides.

## II. TERMS OF REFERENCE

7. We were re-appointed jointly by the Minister of Agriculture and Fisheries, the Minister of Health, the Minister of Food and the Secretary of State for Scotland in May, 1951, and were given the following revised terms of reference :

"To investigate the possible risks from the use in agriculture of toxic substances on the agricultural product and the stored product, and, if protective measures appear desirable, to make recommendations as to their form to the Ministers concerned."

The terms of reference were interpreted in the press notice issued on July 19th, 1951, to mean that we were to enquire whether any risks arise, from the point of view of the consumer of the final product, from the use of toxic chemicals in agriculture and in the storage of food. We have assumed that substances used for the protection of stored food include rodenticides as well as insecticides.

We have not regarded our new terms of reference as including risks to farm animals except in so far as these may affect the consumer of animal products.

### III. COMPOSITION

8. The following is the composition of the Working Party during the second stage of their inquiry :

Professor S. Zuckerman, C.B., F.R.S. (Chairman)	Office of the Lord President of the Council
J. M. Barnes, Esq., M.B.	Medical Research Council
R. H. Barrett, Esq., M.R.C.S., L.R.C.P., D.P.H., D.T.M. & H.	Ministry of Health
A. B. Bartlett, Esq. (from May, 1951 to September, 1951)	Ministry of Agriculture and Fisheries
P. N. R. Butcher, Esq., C.B.E.	Ministry of Health
W. Morley Davies, Esq., M.A., B.Sc., F.R.I.C.	Ministry of Agriculture and Fisheries (National Agricultural Advisory Service)
F. A. Denz, Esq., M.Sc., M.D.	Medical Research Council
N. R. C. Dockeray, Esq.	Ministry of Food
R. A. E. Galley, Esq., Ph.D., A.R.C.S., D.I.C., F.R.I.C.	Office of the Lord President of the Council
R. F. Giles, Esq. (from May, 1951 to December, 1951)	Ministry of Agriculture and Fisheries
C. T. Gimingham, Esq., O.B.E., B.Sc., F.R.I.C.	Ministry of Agriculture and Fisheries (Plant Pathology Laboratory)
W. McAuley Gracie, Esq., M.B.E. (from September, 1951)	Ministry of Agriculture and Fisheries
A. Holness, Esq., M.B.E.	Agricultural Improvement Council
P. G. Inch, Esq., O.B.E. (from January, 1951)	Ministry of Agriculture and Fisheries
B. S. Lush, Esq., M.D., M.R.C.P.	Medical Research Council
J. R. McCallum, Esq., M.C.	Department of Agriculture for Scotland
R. J. Peters, Esq., M.D.	Department of Health for Scotland
H. V. Taylor, Esq., C.B.E., V.M.H., D.Sc., A.R.C.S.	Agricultural Improvement Council
H. Cole Tinsley, Esq., M.B.E.	Agricultural Improvement Council
E. E. Turtle, Esq., M.B.E., M.Sc., Ph.D., F.R.I.C., A.R.C.S., D.I.C. (from June, 1951)	Ministry of Agriculture and Fisheries
H. N. White, Esq.	Ministry of Agriculture and Fisheries

#### JOINT SECRETARIES

K. R. Allen, Esq. (from May, 1951 to August, 1952)	Office of the Lord President of the Council
W. K. Melrose, Esq., B.Sc.	Ministry of Food

#### ASSISTANT SECRETARIES

Mrs. E. D. Cookson	Ministry of Food
Miss D. M. M. Kenyon	Ministry of Food

We were assisted at our meetings with the trade and professional organizations by the following, who joined us in the capacity of assessors :

Professor F. Bergel, Ph.D., D.Sc., F.R.I.C.	Chester Beatty Research Institute
B. A. Ellis, Esq., M.A., F.R.I.C.	Department of the Government Chemist
G. G. Taylor, Esq., M. Agr. Sc.	Agricultural Research Council
Mrs. J. Taylor, B.Sc., M.B.	Public Health Laboratory Service

### IV. SCOPE OF THE INQUIRY

9. We have made our inquiries under five main heads, namely :

- (a) What are the substances which are being used, or which it is proposed should be used, to protect growing crops and stored foods ?
- (b) To what extent are these compounds used, and at what stage are they added, to growing or stored food ?

- (c) To what extent is the food consumed contaminated by these materials ?
- (d) What effect might such contamination have upon the consumer ?  
(In attempting to answer this question we have drawn not only on information collected in this country, but also on the expert knowledge of the World Health Organization of the United Nations and the U.S. Food and Drug Administration.)
- (e) What are the present arrangements for controlling the use of these substances, and have Government Departments sufficient powers to obtain information about new substances before these are brought into use, and to protect the public against substances which, by reason of toxic residues, may be harmful to health ?

We have taken note of the facilities for research and testing which could be provided, or which are at present available, through the Medical Research Council, the Agricultural Research Council, the Department of Scientific and Industrial Research, the scientific research organizations of the various Departments, the Research Associations, the Department of the Government Chemist, the Universities, and other organizations.

## V. THE SUBSTANCES USED

**10.** Apart from contamination during manufacture and processing, food may contain the residues of chemicals applied either when it was grown or when it was stored, or both, or which it has picked up from packaging materials containing such protective substances.

**11.** Many different kinds of toxic chemicals are used in agriculture and on stored food. Insecticides, weed-killers and fungicides are applied to agricultural crops, fruit and vegetables ; chemicals known as "sprout-depressants" are applied to stored potatoes ; other stored foods, such as grain, are fumigated or sprayed or dusted with insecticides. Bacterial and chemical preparations are used against rats which infest food stores.

**12.** The older toxic chemicals used to protect growing or stored crops were in the main inorganic compounds containing lead, arsenic, or copper. The contamination of food with these metals has been examined by the Metallic Contamination Sub-Committee of the Food Standards Committee of the Ministry of Food. This Committee's reports have been published, and we decided that, since working limits have been proposed for arsenic, lead and, in the case of a few specified foods, for copper, and since the identification of these substances should present no problems to the analyst, it was unnecessary for us to discuss them further even though it might prove convenient from the administrative point of view to consider them with the other crop-protecting chemicals.

**13.** We have, therefore, given major attention to the compounds which have been introduced in recent years, such as DDT, BHC, parathion, TEPP, schradan, tecnazene (TCNB), prophan (IPPC) and DNC. A description of crop-protecting chemicals, with details of their chemical formulae, is contained in Appendix A (p. 23).

**14.** We have also considered the dangers which may arise from the use of chemical and bacterial rodenticides.

## VI. THE SEARCH FOR EVIDENCE

15. We approached 45 trade and professional organizations for evidence about the use of toxic chemicals in agriculture and in the storage of foods ; about the risks to public health arising from the use of these substances ; and about the residues which may remain on food at the time of sale to the consumer. Lists of the organizations approached, of those which provided written evidence, and of those which were invited to meet us in order to discuss matters arising from their written evidence, are given in Appendix B (p. 31). Only three organizations declined our invitation, on the grounds that they had no information to offer.

16. The press notice issued in June, 1951, invited any firm or organization which had information on the subject to send details to our secretariat. The response was negligible.

## VII. A SURVEY OF EXISTING KNOWLEDGE

17. The following survey of existing knowledge is based on evidence which we have received directly from organizations in this country, and indirectly from abroad, particularly from the U.S.A.

### Crop-Protecting Chemicals

18. For the purpose of this inquiry, these chemicals can be considered as falling into the following categories :

- (i) Substances whose chemical or physical properties are such that significant quantities are never likely to reach the consumer. Some of the pesticides most dangerous to handle, e.g., TEPP and nicotine, fall into this group.
- (ii) Substances chemically stable and physically persistent, which may remain on crops or stored food until they are consumed. These may be grouped under the following sub-heads :
  - (a) Compounds applied before the edible part of the crop has appeared, and which therefore do not contaminate the food itself, e.g., DNC for weed control in young wheat.
  - (b) Compounds removed during normal storage, processing and cooking, e.g., tecnazene used as a potato sprout-depressant.
  - (c) Compounds about which sufficient is known for tolerances to be recommended, e.g., BHC.
  - (d) Compounds capable of leaving residues in food and which, as little is yet known about their toxicity to man or animals, constitute a possible hazard of unknown degree, e.g., some of the more recently introduced organo-phosphorus compounds and chlorinated hydrocarbons.
  - (e) Compounds reacting with the natural constituents of food to produce compounds which may be toxic, or destroying an essential factor in the food. No chemical at present used for crop protection is known to have the first of these properties. The second is manifested to a limited extent by methyl bromide when used to protect stored wheat.

19. Obviously there can be no sharp line of demarcation between the groups of crop-protecting chemicals we have listed. For example, although an appreciable amount of information about the toxicity of parathion has been published, and routine methods of analysis developed, so that the magnitude of residues in different crops can be determined, no tolerances for this

compound have yet been recommended. Parathion thus falls into group (ii) (d) of the above classification. This group also contains some of the newer organo-phosphorus compounds about which, as far less is known, there is much greater concern.

20. It will be apparent that materials in group (ii) (a), such as the highly toxic DNC and the much less toxic MCPA and 2,4-D, which are used to control weeds in cereal crops, do not constitute a definable consumer risk. The winter washes of fruit trees and bushes are in the same category.

21. Compounds in group (ii) (b) are not present on the food when it is consumed, and therefore are not a potential danger to the public.

22. The compounds comprised in group (ii) (c) are believed not to constitute any risk to the public if the limits laid down are adhered to. A limit of 2.5 parts per million of the gamma-isomer has been recommended for BHC and a tentative limit of 7 parts per million for DDT. No numerical limit has been suggested for tecnazene and propham; the normal technique of their application as potato sprout-depressants has been shown to yield potatoes which contain barely detectable traces of these materials.

23. It is the chemicals of groups (ii) (d) and (e) which have caused us the greatest concern, not because they necessarily present any greater hazard, but because the information does not exist on which to base an estimate of the risk they constitute.

24. Routine methods of analysis for micro-quantities of the chemicals in or on animal and vegetable tissue are not available for all compounds. Even when methods do exist the residues in or on foods have not always been determined. Further, there is a lack of information concerning the decomposition products of systemic insecticides within plants, and of their effects, if any, on the composition of the final food. In any event, it is impossible to conceive of animal experiments which will provide complete information about the toxic effects of chemicals on human beings.

25. The magnitude of the risk to the consumer obviously depends on the nature of the foods that are treated and on the intensity of the treatment. A real danger may arise occasionally from the gross misuse of a pesticide when applied in excessive quantities to a crop just before consumption. The intermittent consumption of very small and undetermined quantities of toxic chemicals constitutes a more hypothetical danger. The greatest threat of chronic toxicity would therefore arise from the widespread treatment with materials of group (ii) (d) and (e) of foods which form the major part of the nation's diet. In seeking information about this point we were immediately faced by the difficulty that, while we might be able to discover how the food we grow ourselves is treated, we were likely to remain incompletely informed about the previous history of the food we import, which is still 60 per cent of what we consume and which contains a large proportion of our staple foods.

26. Although we have not been able to obtain as much information as we should have liked about the proportion of different home-grown crops which receive spray treatment, such information as we have received shows that very little of our staple foods is treated with the materials comprised in group (ii) (d) and (e).

## Treatment of Food

### (a) Treatment of Food in the United Kingdom

#### WHEAT

27. Wheat seed is dressed with fungicides, and, long before the ears appear, the young growing plant is sprayed with selective weed-killers. When the chemicals are properly used the harvested wheat is thus free from contamination. This is still true even if spraying is delayed until some weeds, e.g., charlock, are in flower, although in these circumstances other hazards may arise, for example, to honey bees. There is no evidence that the current methods of using these chemicals in this country result in contamination of the harvested wheat.

28. Stored wheat is sometimes treated chemically to eradicate insects, mites or rodents. Home-grown cereals generally are much less infested than imported cereals, which are consequently the ones more frequently treated in storage. Methyl bromide is the most usual substance employed for this purpose. Its ability to combine with the methionine in wheat led to tests in which heavily overdosed cereals were fed to experimental animals, without causing harmful effects. Although further tests are being carried out, it has already been concluded that the public runs a negligible risk in eating food made from wheat treated in this way. It is worth noting, too, that during the past five years the quantity of wheat treated with methyl bromide in this country has been only about 0.5 per cent of the total consumption.

#### POTATOES

29. Maincrop potatoes are treated with preparations of copper during growth as a protection against blight, and with other sprays to destroy the haulms before harvesting. It has been established that the normal application of these fungicide and haulm-destroying sprays constitutes no hazard to the consumer.

30. The longer-keeping varieties of potatoes, which have to last until the next early crop, are given dressings with sprout-depressants when they are clamped. The two compounds used for this purpose in Britain are tecnazene and prophan, the use of which, in the manner prescribed by the manufacturers, is, in the opinion of the Toxicology Committee of the Medical Research Council, free from risk to the consumer.

#### MEAT AND MILK

31. Meat and milk are not treated directly with chemicals. It has been shown, however, that the consumption by cattle of fodder, previously sprayed with DDT, and the spraying of cattle with this insecticide to protect them from flies, may lead to the presence of DDT in small quantities in the body fat and milk. Flies are far less troublesome in Britain than, for example, in the southern states of the U.S.A. where the practice originated. Our own cattle are therefore rarely sprayed for this purpose with persistent insecticides.

32. Fodder crops, which might be sprayed with DDT, are treated at such times that, when consumed, chemical residues have been lost due to weathering.

## STAPLE FOODS IN GENERAL

33. As far as home-grown staple foods are concerned, such evidence as there is does not therefore support the view that there is at present any danger to the public arising from the use of crop-protecting chemicals. Nor, as has been said, have we been told about any case of fatal or non-fatal illness that can be attributed to the consumption of food made from crops that have been so treated. We wish to emphasize, however, that at the moment only relatively small proportions of the total acreages of crops are treated. For example, chemical weed control has become normal practice with cereals, more so perhaps than any other spraying technique, yet only 25-33 per cent of the total acreage is sprayed. No new danger to the consumer is involved if this particular practice extends further, provided it is carried out properly.

34. If more fodder crops are sprayed than the limited acreage now treated, the public will continue to be immune from the risk of consuming contaminated meat and milk, provided that adequate time intervals exist between spraying and the feeding of the crop to the livestock.

## OTHER CROPS

35. The systemic and contact organo-phosphorus insecticides are mostly used to protect the more expensive seasonal fruit and vegetable crops, such as strawberries, blackcurrants and brussels sprouts. They are also used on hops. We have failed to obtain detailed information about the proportions of the total crops that are treated.

36. Our inquiries have revealed certain isolated instances in which these spray materials, about whose toxic properties we know least, have been used recklessly. In their instructions reputable manufacturers indicate quite clearly both the risk to the operator applying the materials and also the time interval which should elapse between treatment and harvesting. In some cases the time intervals have been determined as a result of studies of the rate of disappearance of the residues from the crops under ordinary climatic conditions. Instructions based on such advice may sometimes be ignored, and it is in these and similar circumstances, i.e., where it is impossible to say what residues are present, that the public is exposed to an unknown risk.

37. Dangers of this kind can be completely averted only if the incorrect use of agricultural chemicals is prevented. An essential step to the prevention of misuse is that the official bodies should be told more about the extent of their potential or actual use, and the conditions under which they are applied. It is also important that no new compounds be introduced into commercial practice until ways of offsetting the hazards they may constitute are agreed. To do this effectively, more data are needed about the amount and persistence of residues under different conditions, and for different crops, of some groups of products already in use, particularly systemic and contact organo-phosphorus insecticides.

### *(b) Treatment of Food before it is Imported*

38. As already stated, we have not been able to obtain much information about the treatment of food before it arrives in this country. Commodities may pass through various hands before being shipped and there are obviously

practical difficulties in transmitting relevant information regarding chemical treatments. Certain overseas producers may, in fact, not wish to disclose the chemical treatments which their crops have received. The problem is not simplified by the fact that in certain cases it may be very difficult, if not impossible, to detect the presence of chemical residues.

39. However, a general picture of foreign practice in the use of agricultural chemicals can be built up from information provided by official and commercial international channels, by technical publications and from certain other sources.

## WHEAT

40. In most of the countries from which we import our cereals, farming is less intensive than in the United Kingdom, and seed dressings and weed-killers are either not used at all or are used only on a small scale. Certain countries are, however, known to treat cereals in storage with methyl bromide and other fumigants. At the present time this practice is very restricted, and it could not relate to more than an exceedingly small part of our total food supplies.

41. Soon after its introduction, DDT was applied, overseas, directly to some of the grain imported into the United Kingdom. This practice has now been abandoned, and of many hundreds of shipments which have arrived during the past few years, only two are known to have been treated in this way.

42. Both BHC and DDT are still occasionally used overseas in warehouses in which cereals are stored before shipment, but, in all cases of which we know, the procedures employed cannot be regarded as objectionable in the light of the standards recommended by the Toxicology Committee of the Medical Research Council in this country.

## OTHER FOODS

43. The more expensive seasonal fruits which are imported are likely to be treated with compounds about which we know least, and this gives ground for uneasiness. During 1951 it was suggested that some shipments had been sprayed with parathion, not only during growth, but after harvesting, to protect them during transport. However, examination of samples from these cargoes, by tests sufficiently sensitive to detect less than one part per million of parathion, failed to reveal its presence. These results are reassuring, but we are aware that they do not preclude the possible arrival of particular consignments of fruit which may have been excessively treated either during growth or after harvesting.

### *General Observations on these Treatments*

44. Thus we have not uncovered, in the course of our inquiry, any firm evidence to support the view that there is at present any public danger arising from the use of protective chemicals on our staple food. However, we need to obtain better information about the use of pest control chemicals on foods before reaching this country, and upon the methods of detecting the presence of residues and measuring them at the time they are imported.

## Rodenticides

45. The infestation of food stores and warehouses by rats and mice is one of the most serious causes of deterioration and loss of stored food, and these animals are also carriers of disease. Their destruction is necessary on both scores.

46. Chemical and bacterial rodenticides are used, and both constitute potential hazards to human beings. The Agricultural Departments have power under Section 19 of the Prevention of Damage by Pests Act, 1949, to make regulations for controlling the methods which may be used by servicing companies for keeping down or destroying rats and mice, including the approval of different methods for use in different circumstances, and prohibiting the use by servicing companies of any method which is not approved. No regulations have yet been made, but the following poisons only are at present used by the Agricultural Departments or advocated by them for general application, namely : zinc phosphide, arsenic, antu, warfarin, and red squill. Other chemical poisons are used in rodenticides that are sold over the counter, and bacterial preparations are used by some contractors.

47. The dangers associated with the use of chemical rodenticides arise essentially from the possibility that they may be accidentally consumed by children, animal pets and farm livestock. The bacterial preparations introduce an additional and more general risk of food poisoning, since food may become contaminated with the bacteria which multiply rapidly under appropriate conditions, e.g., in the excreta of infected rats.

48. Because the cultures contain living organisms, there is no precise knowledge of the numbers or virulence of bacteria present at any given time after laying the baits. Even if the colonies die out under some conditions, they may multiply under others. It is, therefore, much more difficult to control the risk than when a chemical poison of known and stable composition is used.

49. Because of this special risk, about which disquiet has been voiced, we have inquired into the circumstances in which these cultures are manufactured and used as rodenticides.

50. We were particularly impressed by the following points :

- (i) We were told by the firms concerned that the strains used in bacterial rat poisons are of the *danysz* variety of *Salmonella enteritidis*. Nevertheless, we are informed by the Public Health Laboratory Service that the variety *jena*, which is generally considered to be more pathogenic to man, was isolated in 1949 from a sample of commercial rat poison.
- (ii) There is no official control of the varieties of organisms employed, or the methods used for culturing them, for checking their virulence or their use under practical conditions.
- (iii) Very few cases of human illness have been traced directly to the use of bacterial rodenticides, but the source of bacterial food-poisoning has been traced in only a very small proportion of all outbreaks.

(iv) Although most outbreaks of human illness that have been traced to *Salmonella enteritidis* have been attributed to varieties other than *dansyz*, the value of this information must be assessed in relation to point (i), in that there is some doubt as to whether the variety *dansyz* has been used exclusively.

51. The Public Health Laboratory Service and the Medical Research Council consider that the risks are such that the use of bacterial rodenticides should be discouraged with a view to their discontinuance. The Ministry of Agriculture's Infestation Control Division advise that immediate policy should concentrate on ensuring proper care and attention in the preparation and use of these cultures, and that any hasty action against these methods might lead to a serious dislocation in commercial rat-destruction services.

### VIII. THE LAW FOR SAFEGUARDING THE PURITY OF THE CONSUMER'S FOOD

52. There are already on the Statute Book provisions which have the object of ensuring that food sold to the public is free from contamination and harmful ingredients and is fit for human consumption. These provisions are contained in the Food and Drugs Act, 1938, and in various regulations made under that Act. The following are relevant :

- (i) it is an offence to sell for human consumption food which is unfit for that purpose ;
- (ii) if food is prepared, stored or sold in a room, all reasonably necessary steps must be taken to prevent risk of contamination of the food ;
- (iii) it is an offence to add any substance to food so as to render the food injurious to health ;
- (iv) it is an offence to sell to the prejudice of the purchaser any food which is not of the nature, quality or substance demanded, and if this offence arises because some substance has been added to the food the onus rests on the defendant to show that the substance is not injurious to health ;
- (v) it is an offence to import into England or Wales any food which has been declared by a competent authority in any country to be unfit for human consumption ;
- (vi) an authorized officer of a local authority may seize any food which is exposed for sale for human consumption or which is brought into England or Wales by air, and if it appears to him to be unfit for human consumption he may bring it before a magistrate for condemnation. Similar powers may be exercised by an authorized officer of a Port Health Authority in respect of food imported by sea.

The Act also confers on the Ministers of Food and Health powers to make regulations authorizing measures to be taken for the prevention of danger to health from the importation, preparation, transport, storage, exposure for sale, and delivery of foods of various kinds intended for sale or sold for human consumption.

53. Except as indicated below, the duty of executing and enforcing the Act and regulations rests on the local authority, i.e., the borough or district council. Those provisions which relate to the composition or labelling of food are enforced by the 278 Food and Drugs Authorities in England and Wales. Every Food and Drugs Authority is required to appoint a public analyst to enable it to undertake prosecutions based on evidence about the composition of food. The Public Health (Imported Food) Regulations, 1937 and 1948, are enforced by Port Health Authorities in the case of food imported by sea, and by local authorities in the case of food imported by air.

**54.** Authorized officers of local authorities (including Food and Drugs Authorities) and of Port Health Authorities are given appropriate powers of entry, inspection and sampling.

**55.** The position in Scotland is similar. The main statutory provisions are Section 43 of the Public Health (Scotland) Act, 1897, which forbids the sale or possession for sale of unsound food and enables authorized officers of local authorities to enter premises to search for and seize unsound food ; and Sections 1 and 2 of the Food and Drugs (Adulteration) Act, 1928, which corresponds to provisions in the 1938 Act referred to above. The Scottish Imported Food Regulations are similar to the English. All food statutes and regulations are enforced by corresponding authorities, i.e., 55 county and large borough councils.

## **IX. THE PART PLAYED BY INDUSTRY**

**56.** While it is reassuring that we have found no evidence of danger arising from the eating of food made from crops that have been treated with chemicals, we fully appreciate that risks may exist even if they cannot be given scientific definition, and that steps should be taken to prevent a disquieting situation from getting out of hand.

**57.** We have been assured by the larger manufacturers of agricultural chemicals and the firms that apply them that they are aware of the risks attached to the use of the materials, and that they are anxious to co-operate in their reduction. A few manufacturers have facilities for investigating the toxic properties of, and analytical procedures for, the compounds they make or sell. While all do their best to disseminate information about the correct use of their materials, they can do little to ensure that their recommendations are observed.

**58.** The food manufacturers pointed out that they have no way of finding out what chemicals had been used on the food they receive as raw materials. They thought any attempt to get this information from the primary producers was unlikely to be successful, and would only increase the existing difficulties of obtaining raw materials. They do, however, carry out many analyses for materials, such as arsenic, for which limits have been recommended, but it does not seem practical to ask these firms to examine all their products for the suspected presence of a range of compounds, each requiring a special analytical method. Their co-operation could be expected for any reasonable requirements such as the setting up of a permitted limit for a new pesticide.

**59.** We have been assured by all the responsible organizations who provided us with evidence that they are prepared to co-operate in any reasonable measures which might be introduced in order to prevent the hazards we are discussing from materializing.

## **X. PRESENT METHODS OF CONTROLLING THE SALE AND USE OF CROP-PROTECTING CHEMICALS**

**60.** A voluntary "Crop Protection Products Approval Scheme" has been operated by the Agricultural Departments since 1942. The main object of the scheme is to give guidance to the grower in the purchase of crop-protecting

chemicals. Products are approved which comply with standards of composition and performance prescribed by these Departments for the purpose given on the labels of the containers.

61. Thus both the labels and the products are approved. As it is impossible to arrive at a standard of performance of new compounds except after trials lasting about three seasons, the scheme does not normally apply to the most recently-introduced compounds.

62. The scheme is voluntary, and a firm is not bound to submit a new product or a new formulation of an old one for approval before it is marketed. There is, therefore, no official control of new materials, and any manufacturer who is reluctant to disclose the nature of his product can market any product he likes for use on the growing crop, and give whatever instructions he wishes for its use.

63. The voluntary Approval Scheme does not apply to rodenticides or to insecticides and fungicides for use against pests in domestic or industrial premises during the storage of foodstuffs. A compulsory licensing scheme to cover such products was operated by the Ministry of Food, and later by the Agricultural Departments, from 1945 to 1950. When the Prevention of Damage by Pests Act of 1949 came into force powers of licensing were dropped and the retail trade was freed. However, the Agricultural Departments still have power to control by regulations the methods used by commercial servicing companies who destroy pests, although these powers have not yet been used.

64. There is no voluntary scheme for domestic insecticide and rodenticide preparations, nor is there any official control of the products sold, or of their method of use.

65. New administrative precautions are required if a reasonable check on the introduction of new toxic compounds is to be maintained, so that only those about which sufficient toxicological and analytical data are available could enter the market. In view of the industry's willingness to co-operate in any reasonable measures to prevent danger to the public, it should be relatively simple to arrive at a satisfactory solution to this problem.

## XI. OTHER HAZARDS

66. We have dealt so far with the risks that may arise from the ingestion of chemical residues on food. The public, however, may be subjected to certain additional hazards. Although the Pharmacy and Poisons Act, 1933, prohibits the general sale to the public of the more toxic chemicals used for such purposes as pest control, carelessness in the storage and handling of pesticides either in food stores, restaurants or private homes has been a cause of accidents.

67. Under certain conditions, the use of insecticide vapourizers could, for example, result in food becoming contaminated.

68. The handling of growing plants or stored products treated with toxic chemicals may also be a possible source of danger. Thus workers who remove leaves to aid ventilation in hop-gardens may be harmed by the toxic sap which is exuded during this operation from plants which have been treated with systemic insecticides.

69. Of the other situations which can be envisaged, where collateral hazards of a specific nature might arise, it would appear that they are dealt with either by appropriate legislation or arrangements made to meet the specific situation. Thus transport regulations control the packaging and labelling of dangerous chemicals so that risks are minimized. Materials which might render food unpalatable have to be clearly marked, so that they are kept far apart from foodstuffs and empty foodstuffs containers. The laundering of the clothes worn by men who use certain toxic sprays in the field might also constitute a risk, but contractors have already attempted to deal with this problem on their own or by making special arrangements with local laundries.

## XII. EXISTING FACILITIES FOR OBTAINING AND DISSEMINATING INFORMATION ABOUT CROP-PROTECTING CHEMICALS

70. The following facilities exist in this country for obtaining information about the toxicity of chemicals used in agriculture, about residues arising from their use and about analytical methods.

### A. Government Departments and Research Councils

#### (i) *Agricultural Departments*

The Departments are responsible for the preservation of Government stocks of stored products from attack by rodents, insects or mites, and for giving advice to public authorities and to industry, and for enforcement where necessary under the Prevention of Damage by Pests Act, 1949. They develop new techniques for rodent and insect control and work closely with the Pest Infestation Laboratory of the Department of Scientific and Industrial Research. The Departments are also concerned with problems involving the toxicity of agricultural chemicals, and the Plant Pathology Laboratory undertakes the secretarial duties in connection with the approval of pesticides for use in agriculture under the Crop Protection Products Approval Scheme. The agricultural advisory services of the Departments collaborate in the later stages of the development of new measures for crop protection and advise farmers generally on their use.

#### (ii) *Ministry of Food*

THE SCIENTIFIC ADVISER'S DIVISION co-ordinates information about the effect on food of the addition of chemicals during processing and manufacture, and of chemicals which appear adventitiously as residues in food.

#### (iii) *Department of Scientific and Industrial Research*

THE PEST INFESTATION LABORATORY is primarily concerned with research into the infestation of stored foodstuffs both in the United Kingdom and in the Colonies. Its interests include the assessment of the value of fumigants and contact insecticides for the prevention and control of insect attack in foodstuffs ; the elaboration of methods of application ; the design of suitable chemicals and biological methods of assay ; the determination of the residues likely to be found in various products ; and the study of the way the chemicals affect insects.

**THE DITTON LABORATORY.** This institution is concerned with the preservation of fruit and vegetables, and also with the efficiency of pesticides and the possible risks involved.

(iv) *The Agricultural Research Council*

Units of the Agricultural Research Council deal with specific aspects of crop protection. Thus the Unit of Insect Physiology embraces in its investigation the penetration and mode of action of insecticides, and the Unit of Experimental Agronomy includes in its programme fundamental studies and field experiments on selective weed-killers.

The Council also finances fundamental research in University Departments. The Fungicide and Insecticide Research Co-ordination Service is an inter-departmental organization which co-ordinates research and development activities in the agricultural, as well as in the industrial and medical fields.

(v) *Grant-Aided Agricultural Research Institutes*

These institutes, which include such Research Stations as Rothamsted, East Malling and Long Ashton, cover different branches of agriculture and horticulture. Most are concerned with the pests and diseases of one or more crops and with their control by chemical means.

(vi) *The Medical Research Council*

Two units formed by the Council carry out research work in the field of toxic chemicals :

- (a) THE TOXICOLOGY RESEARCH UNIT was formed to assist in the solution of toxicological problems and to pursue research in fundamental questions arising from the problems referred to it. It has been concerned with the mode of action of toxic agents, and with the design of tests rather than with the carrying out of routine examinations.
- (b) THE DEPARTMENT FOR RESEARCH IN INDUSTRIAL MEDICINE, among its other interests, is concerned with cases of poisoning that have occurred in factories and amongst agricultural workers. It is interested in the general problem of the use of agricultural chemicals.

The Toxicology Committee is a standing advisory committee appointed by the Medical Research Council to advise it on research in problems in toxicology. On occasions the advice of this independent committee on toxicity problems has been sought by Government Departments, industrial firms and private individuals.

## B. Industrial Research Associations

The British Baking Industries Research Association, the British Food Manufacturing Industries Research Association and the Research Association of British Flour Millers, which are jointly financed by the Department of Scientific and Industrial Research and the respective industries, possess certain information about the treatment of the commodities with which they are concerned.

## C. Industry

The larger organizations have their own research and analytical laboratories. A few carry out toxicological investigations, although this is done much less frequently and on a smaller scale than in the U.S.A. We have been told, by

representatives of the chemical manufacturers, of analytical methods evolved for the detection of toxic residues on crops, of analytical data on residues, and of toxicity tests. Numbers of the smaller firms, however, had no such data to present, and apparently do not have the laboratory facilities to obtain them. Some firms have analytical work and biological assays done for them by industrial consultants.

The practice of seeking advice from the personnel of University Departments by industrial firms is apparently extensive, but we have no knowledge of its precise magnitude.

#### D. University Departments

University Departments have made valuable contributions to the study of the newer pesticides. Much of the work has been financed by Government funds. In some cases an extramural contract has been given by a Government Department to a University Department to carry out an agreed piece of research ; in others, workers have been seconded from Research Councils to University Departments ; in others, again, funds have been provided to support investigators working on special problems. The results of such work are published as scientific papers, or communicated to the appropriate organization by written report.

### XIII. INFORMATION REQUIRED FOR THE CONTROL OF THE USES OF CROP-PROTECTING CHEMICALS

71. Three things are needed if measures designed to control the use of toxic substances in agriculture are to be effective from the point of view of the consumer :

- (i) A knowledge of the nature and extent of the use of all toxic substances in agriculture and in food storage.
- (ii) Methods of analysis which allow the extent of any food contamination to be determined.
- (iii) Adequate information about the toxic properties of the materials as they affect mammals so as to allow a reasonable assessment to be made of the human risk.

72. These needs would be adequately met if the following conditions were to obtain :

- (i) A firm proposing to sell a new chemical which might contaminate food when used for its advertised purpose, would be responsible for providing adequate information under all the heads listed in paragraph 71 above before offering the material for sale.
- (ii) The Government Departments concerned would satisfy themselves that the public would be adequately protected from any potential risk that might arise from the use of the proposed new material. The Government Department could be advised by a committee such as that suggested in paragraph 76.

73. The existing situation falls short of this ideal in the following respects :

- (i) Many of the firms producing these materials do not have adequate facilities for obtaining the necessary toxicological data about the materials they produce. Nor are there research laboratories which they can pay to do this work for them.
- (ii) Compounds can be marketed and used on food crops without any reference to official bodies.
- (iii) Government Departments have no means of obtaining adequate information about the introduction of new preparations except by the goodwill of the firm concerned. They cannot, therefore, be expected to have a complete knowledge of new compounds and the extent to which they are used.
- (iv) Precise information about the way a given shipment of imported food has been treated before purchase is often unavailable. Even if the organization were available to attempt the formidable task of undertaking analyses of imported food cargoes, it would not be possible to obtain a complete check owing to the difficulties in sampling, and, in some cases, to the absence of chemical methods of detection.

## XIV. GENERAL CONSIDERATIONS

74. British health authorities, and Government Departments concerned, are not grappling in isolation with the questions discussed in this report. Other countries, and particularly the United States of America, where considerable attention has been devoted to the matter, have experienced precisely the same difficulties as we have in attempting to control the ever-increasing number of new chemicals that are being introduced into agricultural and horticultural practice. There is common agreement that it would be as unreasonable to advocate the general suppression of the newer methods of crop protection because of the possible, but undefined, hazards they entail, as it would be to deny the existence of a problem and the need for measures by which it could be minimized.

75. The nature of the problem is plain enough. The elimination of agricultural waste has become the prime purpose of a young and vigorous industry, and we are now faced by a growing number of pest- and weed-killers which increase the efficiency of food production, but whose collateral toxic effects are in general insufficiently known. Public fears about the dangers of chronic illness from eating possibly contaminated food are hardly going to be allayed by statements that there have been no fatal accidents so far, or that chronic illness is not to be expected because none was observed in experimental rats which over a year or so ate food that had been dosed with the new chemicals used in crop protection. Disquiet will give way to confidence only if the public is satisfied that a constant watch is being kept over the problem, and that every reasonable precaution is being taken to obviate possible risks.

76. While several official bodies, referred to in paragraph 70, are already concerned with different aspects of the whole problem, it is our view that some central body is needed whose main function would be to direct or co-ordinate the collection of information about the use of toxic substances in the protection of growing crops and stored food, and to advise the Ministers concerned about administrative measures which may be required to obviate such risks to the eventual consumer as may arise from the use of such substances. It is unnecessary for us to specify the precise constitution of such a central body, but we suggest that, if it consisted of an administrative and technical representative from each of the Departments concerned, it would be able to maintain the necessary links with those separate agencies which are dealing in a specialized way with different aspects of the whole problem.

77. We also suggest that the Committee should have an independent Chairman, and that, since it would be composed of members with other important duties, it would need a permanent secretariat.

78. This central committee would satisfy itself that the appropriate departmental organizations collected all the information about the effects of the various chemicals used to protect crops and stored food, and would have the responsibility of passing the information, together with advice about desirable measures, to the other Departments concerned. It would also be available to Departments for consultation about any new chemicals that industry proposed to introduce. Here its decisions would have to be based on reasonable assessments of possible risks, since they will undoubtedly have to be made

on an amount of evidence far short of the ideal. In addition, the central committee should be charged with the responsibility of finding the most reasonable ways, possibly through the World Health and the Food and Agriculture Organizations of the United Nations, for devising an international code of practice designed to minimize risks to the consumer arising from the use of chemicals in the protection of growing and harvested crops. Such an arrangement would have distinct advantages for a country such as ours which imports more than half its food. At the present moment there are no internationally accepted limits for the contamination by crop-protecting chemicals of commodities going into international trade.

**79.** As we have already indicated, we have not been given any conclusive evidence that the public has ever suffered harm as a result of crop-protecting chemicals—in spite of the number of different possible ways that a hazard to the public could arise. The existence of such a central body charged with the responsibilities we have outlined would help to guard against any deterioration in the present situation. But, to be effective in the administrative field, it would need to call on much more information than exists at the moment.

**80.** It is obvious that the whole area of ignorance about crop-protecting chemicals—whether in the laboratory or in the public mind—must be decreased. We need better administrative measures than exist to find out what current practice is so as to decrease the possibility of the misuse of dangerous chemicals. We need better and easier analytical methods of detecting chemical residues on food. And we need to spread knowledge about these methods and about the risks to which residues might give rise. Industry will do all it can to discover chemicals that will control plant diseases and pests, but which at the same time are not toxic to man and his domestic animals. Until such chemicals are discovered, it is essential that all new crop-protecting chemicals should be scrutinized before being introduced commercially. This should be done by the Departments concerned in consultation, where necessary, with the central committee we have suggested, and manufacturers should be prepared to submit full information about the nature of any new preparations and about such tests as they have undertaken to discover what collateral risks of poisoning, if any, they might entail.

**81.** We do not wish to suggest that any burden should be imposed, either upon industry or on Government Departments, which cannot be discharged. We do not, for example, believe that the food manufacturer could be expected to test all food he received for all possible toxic residues.

## XV. SUMMARY

**82.** We have arrived at the following conclusions :

(i) Efficient agricultural practice necessitates the use of various chemicals in order to protect growing and harvested crops. Most of these chemicals are toxic to more than the particular scourge they are designed to check, and practically all of them are poisonous to man and domestic and wild animals. We have considered the human risk that might arise from the presence of toxic chemical residues in food entering the market, and have approached 45 trade and professional organizations for information about the risks to public health that derive from residues on food. We have not received any evidence of fatal or non-fatal illness that can be attributed to this cause.

- (ii) Special attention must be paid to possible risks of staple articles of diet being contaminated through treatment with chemicals.
- (iii) Toxic materials have occasionally been improperly used, and small quantities may find their way into food. This indicated the need for closely supervising the use of these chemicals.
- (iv) Only 40 per cent of our food is grown at home and only a fraction of this is ever treated by toxic chemicals at any stage. Of the 60 per cent that is imported little is known of the methods of treatment or of the chemicals used.
- (v) Bacterial rodenticides may create special risks of food contamination.
- (vi) The Food and Drugs Act, 1938, and (in Scotland) the Food and Drugs (Adulteration) Act, 1928, already prohibit the sale of food to which any substance has been added which renders the food injurious to health. It is, therefore, in the manufacturers' own interests to comply with any methods of control which would ensure that foods are free from toxic materials.
- (vii) Many manufacturers of crop-protecting chemicals already take some precautions to assure themselves that if their instructions are followed no risk from residues attends the use of the substances they market. Most contractors who use the chemicals are also concerned to follow a strict code of practice.
- (viii) In spite of (vii) the evidence suggests that there are compounds in commercial use about whose residues on food little is known.
- (ix) The authorities responsible for enforcing the Food and Drugs Act and the regulations made under it should be advised about the crops on which the newer crop-protecting chemicals may have been used and about methods of analysis for detecting contamination.
- (x) There is a general lack of information about the use of crop-protecting chemicals. The situation could be improved by augmenting the existing facilities for obtaining such information.

## XVI. RECOMMENDATIONS

### 83. We recommend :

- (i) That an Advisory Committee be appointed by the appropriate Departments with the following general functions :
  - (a) To advise Departments on problems relating to the risks to the consumer arising from the use of toxic substances on agricultural products and in the storage of food.
  - (b) To guide Departments as to the scope of the initial investigations which should be undertaken by manufacturers and about the evidence which should accompany proposals to introduce new substances.
  - (c) To maintain close contact with such other official and unofficial agencies as may be concerned in different aspects of the problem, so as to be closely informed as possible about hazards.
  - (d) To advise Departments where necessary about the maximum permissible limits for residues arising from the use of toxic substances on agricultural products and in the storage of food.

The Committee should be provided with such staff as will permit it to discharge its duties.

(ii) That a general statement should be issued by Departments that proposals by manufacturers and distributors for the use of new toxic substances on agricultural products, or for new users of those already in use should be notified to them. Manufacturers and importers should agree that new chemicals or new formulations would not be introduced into practice until cleared with the Departments concerned, if necessary on the advice of the Committee referred to in (i) above. Manufacturers and importers should therefore be prepared to submit full information about the constitution of preparations ; about methods available for determining the extent of any contamination ; about the toxic properties of residues in relation to risks to human beings ; about tests carried out to establish levels of toxicity, and also any other information which might be asked for by the Departments concerned. These arrangements should also apply to any chemicals at present in use about which information is thought to be inadequate. Labelling should also be agreed with the Departments concerned to see that correct instructions about the use of the preparations are clearly stated.

(iii) That general enabling powers should be sought, as soon as opportunity offers, for use if further experience shows that the making of statutory regulations is necessary to ensure that arrangements on the lines proposed in (ii) above work effectively.

(iv) That the advisory services of the Agricultural Departments should closely follow the use of these materials and, by advice and guidance to users, should ensure that as far as possible compounds are used correctly for treating the appropriate diseases or pests.

(v) That further studies be made of the desirability of registering all firms or individuals who apply these materials by contract, or of farmers who undertake to provide a similar service to other farmers, so as to ensure that they are sufficiently aware of the proper techniques and times of application of the materials they handle.

(vi) That research should be encouraged with the objects of :

- (a) developing substances effective in destroying weeds, fungi, insects and other pests, but which are less toxic to man than those in current use, or which do not persist and remain in the food he consumes ;
- (b) determining the toxic properties of any substances appearing in food as a result of the use of crop-protecting chemicals.

(vii) That, as analytical control will be necessary, if permitted limits are instituted, the Department of the Government Chemist and other appropriate Departments, in collaboration with the Society of Public Analysts and Other Analytical Chemists, should be invited to seek methods of determining micro-quantities of toxic substances in food, which could be used in Public Analysts' Laboratories.

(viii) That the firms and Departments concerned should give consideration to the expert view that because of possible risks to the public health, it is desirable to avoid the use of bacterial rodenticides. Time should be allowed for any change-over to other methods not involving the same risks, so as to avoid serious interference with rat destruction work. So long as they are in use bacterial rodenticides should only be manufactured and used subject to the following safeguards :

- (a) Bacterial rodenticides should be limited to those containing the *danysz* variety alone of *Salmonella enteritidis*.
  - (b) The use of bacterial rodenticides should not be permitted in kitchens or other premises in which food is prepared or sold.
  - (c) Bacterial rodenticides should be used only by skilled operators employed by recognized firms.
  - (d) Unconsumed baits containing bacterial cultures should be removed.
- (ix) That international action should be encouraged with the aim of controlling the use of certain chemical treatment of food going into international trade and of promoting the exchange of information.

Signed on behalf of the Working Party,

**S. ZUCKERMAN**

*Chairman.*

*April, 1953.*



## APPENDIX A

### CROP-PROTECTING CHEMICALS

#### Description and Formulae

Materials listed below have been grouped as follows : I. Insecticides, II. Fungicides, III. Herbicides, and IV. Rodenticides. All the chemicals mentioned are in commercial use but some of the new materials are at present used only on a restricted scale.

**Column 1.** The accepted common name (British Standard 1831 : Part I : 1952) is given. Where a common name does not exist, the code letters used by the commercial firm concerned with development of the chemical are used as a reference.

**Column 2.** The chemical name given is the one most generally accepted although alternative names are sometimes used.

**Column 3.** Brief references are given to the categories of commodities on which the chemicals are employed. The following classification has been adopted :

*Stored products* include crops which may be treated after harvest for prevention or eradication of insect pests during storage or in transit.

*Growing plants* include all stages of crops which may be treated up to harvest.

*Livestock* refers to sheep and cattle treated with insecticides for control of external parasites and other pests such as flies and mosquitoes.

*Seed* is a special group in which chemicals are used to control pests and diseases by treating the seed from which a crop will later be grown.

*Soil* is included to indicate those chemicals applied to the soil for prevention of disease or pests on growing plants.

*Ground baits* form a special group of chemicals applied to the surface of the soil to attract and kill pests which would otherwise attack the adjacent crops.

It should be noted that this classification serves only to indicate the type of commodity treated and does not mean that any one chemical is used on all commodities in a given classification. Thus although DDT is used on some growing plants the great majority of crops are not treated.

In column 3 an indication is also given as to whether the compound is used in the United Kingdom (U.K.) or whether it is at present used only overseas.

**Column 4.** Gives information on the persistence and site of action of the chemicals only as insecticides, fungicides, or herbicides and does not in any way indicate their action towards man. The following terms are employed :

*Persistent.* Compound persists unchanged or in a changed but active form for several months unless removed by weathering or other mechanical means or by chemical break-down.

*Semi-persistent.* Compound commences to break down chemically to inactive compounds immediately or is lost by volatilization but active residues still persist for one to several weeks.

*Non-persistent.* Compound breaks down chemically or is lost by volatilization within a few days.

*Surface contact.* Chemical acts by contact. The chemical may be applied direct to the insect, fungus or plant or may provide a protective cover on the plant, seed or animal with which the insect or fungus later comes in contact.

*Stomach poison.* The chemical is ingested by the insect and acts through the gut.

*Fumigant.* The chemical is sufficiently volatile to form a toxic vapour and enter the insect or fungus in this state.

*Systemic.* The chemical enters the plant tissue and is distributed through the plant. Compounds distributed through the plant are toxic to insects, or inhibit plant growth.

*Sprout-depressant.* A chemical applied to stored potatoes to retard germination.

# I. INSECTICIDES

<i>Common Name or Code Number</i>	<i>Chemical Name</i>	<i>Type of Commodity Treated</i>	<i>Persistence and Site of Action</i>
<b>A. Halogenated Hydrocarbon Compounds</b>			
BHC (mixed isomers) <i>Gamma-BHC</i>	1 : 2 : 3 : 4 : 5 : 6-hexachloro- <i>cyclohexane</i> . Benzene hexachloride. <i>Gamma</i> -isomer of the above.	Stored products ; growing plants ; livestock ; seeds ; soil ; ground baits ; U.K. and overseas.	Persistent ; surface contact ; stomach poison ; fumigant.
DDT	A complex chemical mixture, in which <i>pp'</i> -DDT predominates.	Stored products ; growing plants ; livestock ; soil ; U.K. and overseas.	Persistent ; surface contact ; stomach poison.
<i>pp'</i> -DDT	1 : 1 : 1-trichloro-2 : 2-di- ( <i>p</i> -chlorophenyl) ethane.	"	"
TDE	1 : 1-bis ( <i>p</i> -chlorophenyl) 2 : 2-dichloroethane.	Growing plants ; livestock ; overseas.	"
Methoxychlor	1 : 1 : 1-trichloro-2 : 2-di- (4-methoxyphenyl) ethane.	"	"
Dieldrin	Contains not less than 85% of 1 : 2 : 3 : 4 : 10 : 10- hexachloro-6 : 7-epoxy- 1 : 4 : 4a : 5 : 6 : 7 : 8 : 8a- octahydro-1 : 4 : 5 : 8- dimethanonaphthalene and not more than 15% of insecticidally active related compounds.	Growing plants ; soil ; overseas.	"
Aldrin	Contains not less than 95% of 1 : 2 : 3 : 4 : 10 : 10- hexachloro-1 : 4 : 4a : 5 : 8 : 8a- hexahydro-1 : 4 : 5 : 8-di- methanonaphthalene and not more than 5% of insecticidally active related compounds.	Growing plants ; soil ; ground baits ; overseas.	Persistent ; surface contact ; stomach poison ; fumigant.
Toxaphene	Chlorinated camphene (67-69% chlorine).	Growing plants ; livestock ; ground baits ; U.K. and overseas.	Persistent ; surface contact ; stomach poison.
Chlordane	2 : 3 : 4 : 5 : 6 : 7 : 10 : 10- octachloro-4 : 7 : 8 : 9- tetrahydro-4 : 7- <i>endomethyleneindan</i> .	Growing plants ; livestock ; soil ; ground baits ; overseas.	"
K.6451	4-chlorophenyl-4-chloro- benzene sulphonate.	Growing plants ; overseas.	Persistent ; surface contact.
PCPBS	4-chlorophenylbenzene- sulphonate.	Growing plants ; U.K.	Persistent ; surface contact.
88-R	2-( <i>p</i> - <i>tert</i> -butylphenoxy) isopropyl-2-chloroethyl sulphite.	Growing plants ; overseas.	"
Carbon tetrachloride	Carbon tetrachloride	Stored products ; soil ; U.K. and overseas.	Non-persistent ; fumigant.

<i>Common Name or Code Number</i>	<i>Chemical Name</i>	<i>Type of Commodity Treated</i>	<i>Persistence and Site of Action</i>
Methyl bromide	Methyl bromide.	Stored products ; soil ; U.K. and overseas.	Non-persistent; fumigant.
Ethylene dibromide	Ethylene dibromide.	„	„
Ethylene dichloride	Ethylene dichloride.	„	„
Tetrachloroethane	Tetrachloroethane.	Growing plants ; U.K.	Persistent.
DD	1:2-dichloropropane, 1:3-dichloropropylene in approximately equal proportions.	Soil ; U.K. and overseas.	Semi-persistent.
Methylallyl chloride	Methylallyl chloride.	Stored products ; overseas.	Non-persistent ; fumigant.
Dichloroethyl ether	Dichloroethyl ether.	Stored products ; overseas.	„
Chloropicrin	Chloropicrin.	Stored products ; soil ; U.K. and overseas.	„
Dichloronitroethane	Dichloronitroethane.	Stored products ; overseas.	Persistent.

### B. Organophosphorus Compounds

TEPP (HETP)	Tetraethyl pyrophosphate.	Growing plants ; U.K. and overseas.	Non-persistent ; surface contact.
Parathion	<i>OO</i> -diethyl <i>o</i> - <i>p</i> -nitrophenyl thionphosphate.	Growing plants ; soil ; U.K. and overseas.	Semi-persistent ; surface contact ; stomach poison.
Paraoxon	Diethyl- <i>p</i> -nitrophenyl- phosphate.	Growing plants ; U.K.	Semi-persistent ; stomach poison ; systemic.
E.838	Diethylthiophosphoric acid ester of 7-hydroxy- 4-methylcoumarin.	Growing plants ; overseas.	Semi-persistent ; surface contact ; stomach poison.
Malathon	0 : 0-dimethyl dithio- phosphate of diethyl- mercaptosuccinate [formerly known as S- (1:2-dicarbethoxyethyl) 0:0-dimethyldithiophosphate].	„	Semi-persistent ; surface contact.
Schradan	Bisdimethylaminophosphorous anhydride or Octamethyl- pyrophosphoramido.	Growing plants ; U.K. and overseas.	Semi-persistent ; systemic.
Dimefox	Bis(dimethylamino) fluorophosphine oxide.	„	„
Mipafox	Bis(monoisopropylamino) fluorophosphine oxide.	„	„

<i>Common Name or Code Number</i>	<i>Chemical Name</i>	<i>Type of Commodity Treated</i>	<i>Persistence and Site of Action</i>
Systox	Diethylthiophosphoric ester of $\beta$ -ethyl mercaptoethanol.	Growing plants ; overseas.	Semi-persistent ; systemic.
EPN	0-ethyl o-p-nitro-phenyl benzene thiophosphate.	„	Semi-persistent ; surface contact ; stomach poison.

### C. Nitrophenol Compounds

DNC	2-methyl-4 : 6-dinitrophenol.	Dormant trees ; U.K. and overseas.	Semi-persistent ; surface contact.
Dinoseb	2-(1-methyl-n-propyl)-4 : 6-dinitrophenol or 2-sec-butyl-4 : 6-dinitrophenol, or 2 : 4-dinitro-6-sec-butylphenol.	Dormant trees ; U.K. and overseas.	Semi-persistent ; surface contact.

### D. Compounds of Vegetable Origin

Nicotine	3-(1-methyl-2-pyrrolidyl) pyridine.	Stored products ; growing plants ; U.K. and overseas.	Non-persistent ; surface contact ; stomach poison ; fumigant.
Pyrethrum	Mixture of Pyrethrins I and II and Cinerins I and II extracted from pyrethrum flowers.	Stored products ; growing plants ; livestock ; U.K. and overseas.	Semi-persistent ; surface contact.
Derris	Mixture of rotenone and related compounds extracted from roots of Derris, Lonchocarpus, and Tephrosia spp.	Growing plants ; livestock ; U.K. and overseas..	Semi-persistent ; surface contact ; stomach poison.

### E. Inorganic Compounds

Lead arsenate	Diplumbic hydrogen arsenate.	Growing plants ; soil ; U.K. and overseas.	Persistent ; stomach poison.
Basic lead arsenate	Mixture of ill-defined basic arsenates.	„	„
Calcium arsenate	Calcium arsenate.	„	„
Paris green	Copper aceto-arsenite.	Soil ; ground baits ; U.K. and overseas.	„
Sodium fluorosilicate	Sodium fluorosilicate.	Growing plants ; ground baits ; U.K. and overseas.	„
Cryolite	Sodium fluoroaluminate.	„	„
Barium fluosilicate	Barium fluorosilicate.	„	„
Calomel	Mercurous chloride.	Soil ; seed ; U.K. and overseas.	„

<i>Common Name or Code Number</i>	<i>Chemical Name</i>	<i>Type of Commodity Treated</i>	<i>Persistence and Site of Action</i>
<b>F. Miscellaneous Compounds</b>			
Carbon disulphide	Carbon disulphide.	Stored products ; soil ; U.K. and overseas.	Non-persistent; fumigant.
Prussic acid	Hydrogen cyanide.	Stored products ; soil ; growing plants ; U.K. and overseas.	„
Calcium cyanide	Calcium cyanide.	„	„
Ethylene oxide	Ethylene oxide.	Stored products ; U.K. and overseas.	„
Azobenzene	Azobenzene.	Growing plants ; U.K. and overseas.	Semi-persistent ; fumigant.
Azoxybenzene	Azoxybenzene.	„	„
Allethrin	<i>dl</i> -2-allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one ester of a mixture of <i>cis</i> -and <i>trans</i> - <i>dl</i> -chrysanthemum monocarboxylic acid.	Stored products ; livestock ; overseas.	Semi-persistent ; surface contact.
Piperonyl butoxide	(3 : 4-methylene dioxy-6-propyl benzyl) (butyl) diethylene glycol ether.	Synergist for pyrethrins ; U.K. and overseas.	Semi-persistent ; surface contact.
Tar oil	Phenolic compounds, obtained from coal-tar distillates.	Dormant trees ; U.K. and overseas.	„
Petroleum oil (summer)	Highly-refined light petroleum oil.	Growing plants ; U.K. and overseas.	Persistent ; surface contact.
Petroleum oil (winter)	Partially-refined heavy petroleum oil.	Dormant trees ; U.K. and overseas.	„

## II. FUNGICIDES

<i>Common Name or Code Number</i>	<i>Chemical Name</i>	<i>Type of Commodity Treated</i>	<i>Persistence and Site of Action</i>
<b>A. Inorganic Compounds</b>			
Bordeaux mixture	Chemical combination of copper sulphate and lime.	Growing plants ; U.K. and overseas.	Persistent ; contact.
Burgundy mixture	Chemical combination of copper sulphate and sodium carbonate in water.	"	"
Copper compounds	Various compounds such as copper oxychloride, copper carbonate and copper oxide.	Growing plants ; seeds ; U.K. and overseas.	"
Sulphur	Elemental sulphur in various physical forms.	"	"
Lime sulphur	Mixture containing calcium polysulphides.	"	"
Corrosive sublimate	Mercuric chloride.	Growing plants ; soils ; U.K. and overseas.	"
Calomel	Mercurous chloride.	Seed ; U.K. and overseas.	"
<b>B. Dithiocarbamate Compounds</b>			
Ferbam	Ferric dimethyl-dithiocarbamate.	Growing plants ; U.K. and overseas.	Semi-persistent ; contact.
Ziram	Zinc dimethyldithiocarbamate.	"	"
Nabam	Disodium ethylenebis-(dithiocarbamate).	"	"
Zineb	Zinc ethylenebis-(dithiocarbamate).	"	"
<b>C. Organo-mercury Compounds</b>			
PMC	Phenyl mercuric chloride.	Growing plants ; U.K. and overseas.	Persistent ; contact.
PMA	Phenyl mercuric acetate.	"	"
Aliphatic mercury compounds	Various compounds such as ethyl mercuric chloride, iodide and phosphate.	Seed ; U.K. and overseas.	"
Aromatic mercury compounds	Various complex compounds such as hydroxy mercuric cresol.	Seed ; U.K. and overseas.	Persistent ; contact.

<i>Common Name or Code Number</i>	<i>Chemical Name</i>	<i>Type of Commodity Treated</i>	<i>Persistence and Site of Action</i>
<b>D. Miscellaneous Organic Compounds</b>			
Thiram	Bis(dimethylthiocarbamyl) disulphide.	Growing plants ; soil ; seed ; U.K. and overseas.	Semi-persistent ; contact.
Tecnazene	Tetrachloro nitrobenzene.	Seed (potatoes) ; U.K. and overseas.	(Sprout-depressant).
Salicylanilide	Salicylanilide.	Growing plants ; U.K. and overseas.	Persistent ; contact.
Captan	<i>N</i> -trichloromethyl thio tetrahydro phthalimide.	Growing plants ; overseas.	,
341-SC	Heptadecyl glyoxalidine.	,	,
Chloranil	Tetra chloro- <i>p</i> -benzo-quinone.	Growing plants ; seed ; overseas.	,
Dichloro-naph-thoquinone	2:3-dichloro, 1-4-naph-thoquinone.	,	,
Formalin	Formaldehyde.	Soils ; U.K. and overseas.	Semi-persistent ; surface contact.

### III. HERBICIDES

<i>Common Name or Code Number</i>	<i>Chemical Name</i>	<i>Type of Commodity Treated</i>	<i>Persistence and Site of Action</i>
<b>A. Inorganic Compounds</b>			
Sodium chlorate	Sodium chlorate.	Growing plants ; U.K. and overseas.	Semi-persistent ; contact.
Sodium arsenite	Sodium arsenite.	,	Persistent ; contact.
Oil of vitriol	Sulphuric acid.	,	Non-persistent ; contact.

### B. Organic Compounds

2,4-D	2 : 4-dichlorophenoxy-acetic acid.	Growing plants ; U.K. and overseas.	Persistent ; systemic.
2,4,5,-T	2 : 4 : 5-trichlorophenoxy-acetic acid.	,	,
MCPA	4-chloro-2-methylphenoxy-acetic acid.	,	,
Propham	<i>Isopropyl N</i> -phenyl-carbamate.	,	Persistent ; contact (Sprout-depressant).

<i>Common Name or Code Number</i>	<i>Chemical Name</i>	<i>Type of Commodity Treated</i>	<i>Persistence and Site of Action</i>
Proxan (Sodium)	Sodium isopropyl xanthate.	Growing plants; U.K. and overseas	Semi-persistent ; contact.
Sodium trichloroacetate	Sodium trichloroacetate.	„	Persistent ; contact; systemic.
DNC	2-methyl-4 : 6-dinitrophenol.	„	Semi-persistent ; contact.
Dinoseb	2-(1-methyl-n-propyl)- 4 : 6-dinitrophenol or 2-sec- butyl-4 : 6-dinitrophenol, or 2 : 4-dinitro-6-sec-butyl- phenol.	„	„
Dinex	2:4-dinitro-6-cyclohexyl- phenol.	„	„
Dinosam	2-(1-methyl-n-butyl)-4 : 6- dinitrophenol.	„	„
Tar acids	Phenolic compounds obtained from coal-tar distillates.	„	Semi-persistent ; contact.
Petroleum oils	Distillates high in unsaturated hydrocarbons.	„	Persistent.

#### IV. RODENTICIDES

<i>Common Name</i>	<i>Chemical Name</i>
Zinc phosphide	Zinc phosphide.
Phosphorus	Phosphorus.
Barium carbonate	Barium carbonate.
Thallium sulphate	Thallium sulphate.
Arsenic	Arsenious oxide.
Antu	Alpha-naphthyl thiourea.
Red squill powder	Red squill powder.
Warfarin	3(alpha-acetonylbenzyl)4- hydroxycoumarin.
Bacterial preparations	Based on cultures of <i>Salmonella</i> <i>enteritidis</i> , variety <i>danysz</i> .

## APPENDIX B

### I Organizations which were invited to give written evidence to the Working Party

The Research Association of British Flour Millers.  
The British Food Manufacturing Industries Research Association.  
The Fruit and Vegetable Canners' Association Research Station.  
The British Baking Industries Research Association.  
The Cake and Biscuit Alliance Ltd.  
The Cocoa, Chocolate and Confectionery Alliance Ltd.  
The Food Manufacturers' Federation Incorporated.  
The National Dried Fruit Dealers' (War Emergency) Federation.  
The National Federation of Fruit and Potato Trades Ltd.  
The Joint Council of British Potato and Vegetables Merchants' Associations.  
The Scottish Potato Trade Executive.  
The Scottish Seed and Nursery Trades Association.  
The Horticultural Trades Association.  
The British Agricultural Contractors' Association.  
The National Federation of Corn Trade Associations.  
The National Association of British and Irish Millers Ltd.  
The Scottish Oatmeal Millers' Association.  
The British Pearl Barley Millers' Association.  
The Brewers' Society.  
The Maltsters' Association of Great Britain.  
The Scotch Whisky Association.  
The Hops Marketing Board.  
The National Union of Agricultural Workers.  
The National Farmers' Union.  
The Ulster Farmers' Union.  
The National Farmers' Union of Scotland.  
The Trades Union Congress.  
The Co-operative Union Ltd. (Parliamentary Committee).  
The Society of Public Analysts and Other Analytical Chemists.  
The Association of Public Analysts of Scotland.  
The Royal Institute of Chemistry.  
The Chemical Society.  
The Society of Chemical Industry.  
The Royal Sanitary Institute.  
The Pasteur Institute.  
The National Committee of Port Public Warehouse Keepers' Associations.  
The Association of Sea and Air Port Health Authorities.  
The Association of Industrial Medical Officers.  
The British Medical Association.  
The Medical Practitioners' Union.  
The Society of Medical Officers of Health.  
The Ministry of Labour and National Service (Factory Inspectorate).  
The Association of British Insecticide Manufacturers.  
The Association of British Chemical Manufacturers.  
The Industrial Pest Control Association.

### II Organizations which provided written evidence

The Research Association of British Flour Millers.  
The British Baking Industries Research Association.  
The Cocoa, Chocolate and Confectionery Alliance Ltd.  
The Food Manufacturers' Federation Incorporated.  
The National Dried Fruit Dealers' (War Emergency) Federation.  
The National Federation of Fruit and Potato Trades Ltd.  
The Scottish Potato Trade Executive.  
The National Union of Agricultural Workers.  
The Scottish Oatmeal Millers' Association.  
The British Pearl Barley Millers' Association.  
The Brewers' Society.  
The Maltsters' Association of Great Britain.  
The Scotch Whisky Association.  
The Hops Marketing Board.

The National Farmers' Union.  
The Co-operative Union Ltd. (Parliamentary Committee).  
The Pasteur Institute.  
The National Committee of Port Public Warehouse Keepers' Associations.  
The Association of Sea and Air Port Health Authorities.  
The Association of British Insecticide Manufacturers.  
The Industrial Pest Control Association.

### **III Organizations which were invited to give oral evidence**

The Research Association of British Flour Millers.  
The British Food Manufacturing Industries Research Association.  
The British Baking Industries Research Association.  
The Cocoa, Chocolate and Confectionery Alliance Ltd.  
The Food Manufacturers' Federation Incorporated.  
The British Agricultural Contractors' Association.  
The Association of Sea and Air Port Health Authorities.  
The Association of British Insecticide Manufacturers.  
The Industrial Pest Control Association.  
The Pest Infestation Laboratory (Department of Scientific and Industrial Research).  
The Ditton Laboratory (Department of Scientific and Industrial Research).  
The Cheshunt Research Station.  
The East Malling Research Station.  
The Long Ashton Research Station.

### **IV Organizations which provided oral evidence**

The Research Association of British Flour Millers.  
The British Food Manufacturing Industries Research Association.  
The British Baking Industries Research Association.  
The Cocoa, Chocolate and Confectionery Alliance Ltd.  
The Food Manufacturers' Federation Incorporated.  
The British Agricultural Contractors' Association.  
The Association of British Insecticide Manufacturers.  
The Industrial Pest Control Association.  
The Pest Infestation Laboratory (Department of Scientific and Industrial Research)  
The Cheshunt Research Station.  
The East Malling Research Station.  
The Long Ashton Research Station.

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